

# New Species of Cypraeidae (Mollusca: Gastropoda) from the Miocene of California and the Eocene of Washington

by

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*Abstract.* Two new species of cypraeid gastropods are described from localities in Los Angeles County, California and Lewis County, Washington. *Zonaria* (*Zonaria*) *emmakingae* from the lower to middle Miocene ("Temblor Stage" = uppermost Burdigalian/Langhian), Topanga Canyon Formation is the earliest report of this genus and subgenus from the eastern Pacific region. *Nucleolaria cowlitziana* from the middle to upper Eocene ("Tejon Stage" = uppermost Bartonian/lowermost Priabonian), Cowlitz Formation is the earliest report of this genus worldwide and the only record of the genus from the eastern Pacific. Living species that are closely related to the two new species are also reviewed.

## INTRODUCTION

Although the family Cypraeidae is well represented in the Cretaceous and much of the Cenozoic of the eastern Pacific (Ingram, 1947a, b; Groves, 1990, 1992), cypraeids are rare in Miocene deposits of California. Described herein is the first well-preserved cypraeid species from the Miocene of California. Generic and specific determinations cannot be made of the only previously reported cypraeids of the California Miocene: *Cypraea* n. sp. "A" from the Vaqueros horizon of Malibu Canyon and Santa Rosa Island, and *Cypraea* n. sp. "C" from the Temblor faunule of Topanga Canyon, southern California of Loel & Corey (1932). These poorly preserved internal molds superficially resemble the Recent Panamic species *Zonaria* (*Pseudozonaria*) *robertsi* (Hidalgo, 1906). The earliest appearance of *Zonaria* s.s. in the eastern Pacific is recorded here with the description of *Zonaria* (*Zonaria*) *emmakingae* Groves, sp. nov. from the lower to middle Miocene ("Temblor Stage" of Weaver et al. (1944) [= uppermost Burdigalian/Langhian]), Topanga Canyon Formation, Los Angeles County, southern California (Figure 1).

Also described herein is *Nucleolaria cowlitziana* Groves, sp. nov. from the middle to late Eocene ("Tejon Stage" of Clark & Vokes (1936) [= uppermost Bartonian/lowermost Priabonian]), Cowlitz Formation, Lewis County, Washington (Figure 1), the first Cenozoic cypraeid species described from Washington and the only record of the

genus in the eastern Pacific. The only other true cypraeid described from Washington is the Upper Cretaceous species *Palaeocypraea* (*Palaeocypraea*) *suciensis* (Whiteaves, 1895) from Sucia Island, San Juan Island (Groves, 1990).

The two new species here described represent the first appearances in the eastern Pacific of two lineages that have become diverse in the Recent fauna. This paper describes and figures these new species as well as illustrating and providing a brief synopsis of previously described, related species.

Abbreviations used for institutional catalogue and locality numbers are as follows: ANSP, Academy of Natural Sciences of Philadelphia; BMNH, The Natural History Museum, London; BPBM, Bernice P. Bishop Museum, Honolulu; CAS, California Academy of Sciences, San Francisco; LACM, Natural History Museum of Los Angeles County, Malacology Section; LACMIP, Natural History Museum of Los Angeles County, Invertebrate Paleontology; SDSU, San Diego State University; and UCMP, University of California Museum of Paleontology, Berkeley.

Measurement parameters are defined as follows: length = greatest distance between anterior and posterior ends; width = greatest distance between lateral margins; and height = greatest distance between base and dorsum.

The classification herein follows that of Schilder & Schilder (1971). The synonymies for the Recent species are limited to those with good illustrations or those that

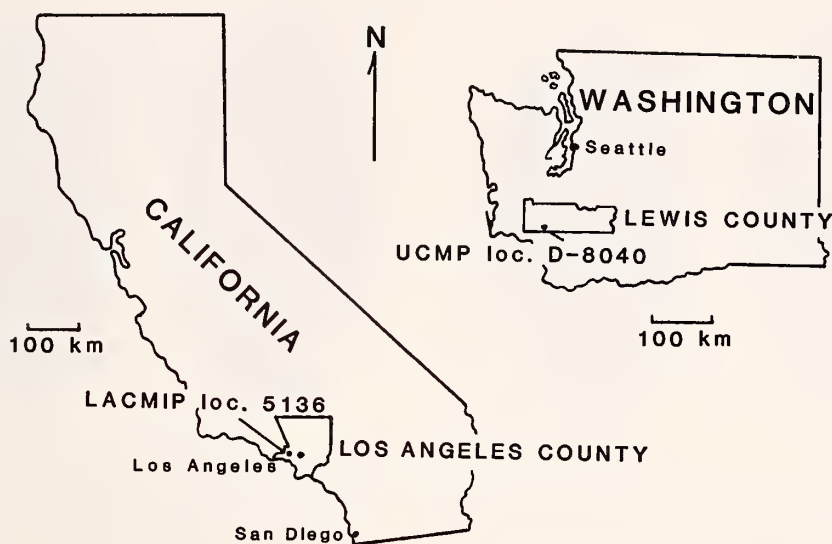


Figure 1

Index maps showing type localities of the new species of Miocene and Eocene cypraeids described herein. Localities are described in the "Localities Cited" section.

add pertinent taxonomic information. Citations of all fossil references are included in the synonymies and/or the stratigraphic distribution section, whether or not illustrated.

#### SYSTEMATIC PALEONTOLOGY

Superfamily CYPRAEACEA Rafinesque, 1815

Family CYPRAEIDAE Rafinesque, 1815

Subfamily ERRONEINAE Schilder, 1927

Tribe Zonariini Schilder, 1941

Genus *Zonaria* Jousseume, 1884

Subgenus *Zonaria* Jousseume, 1884

**Type Species:** *Cypraea zonata* Lamarck, 1810 (not Chemnitz, 1788) [= *Cypraea zonaria* Gmelin, 1791], by original designation. Recent, West Africa.

**Diagnosis:** Shell medium to large in size, pear-shaped; labial lip narrow, with teeth elongated; aperture straight, anteriorly curved toward columella; teeth on posterior canal weak; anterior columellar tooth oblique; fossula narrow with inner marginal teeth weak or absent; anterior and posterior canals deep; spire without furrow but commonly ribbed.

**Remarks:** *Zonaria* has been subdivided into *Zonaria* s.s., *Neobernaya* Schilder, 1927 [type species = *Cypraea spadicea* Swainson, 1823], and *Pseudozonaria* Schilder, 1927 [type species = *Cypraea arabicula* Lamarck, 1810]. *Zonaria* s.s. differs from *Z. (Neobernaya)* by its pear shape rather than

oblong shape, its lengthened anterior end, and stronger dentition. The fossula of *Zonaria (Pseudozonaria)* is denticulated and wider than in *Zonaria* s.s.

The earliest known species of *Zonaria* is *Z. (Z.) heilprinii* (Dall, 1890) from the lower Miocene (Aquitanian), Tampa Formation of Hillsborough County, Florida. West coast Miocene species of *Zonaria* ranged as far north as the central Santa Monica Mountains, Los Angeles County, California (at least 34°8'N) in the eastern Pacific (herein), Calhoun County, Florida (ca. 30°26'N) in the Caribbean (Dolin, 1991), and Torino, Piedmont Dist., Italy (ca. 45°5'N) in Europe (Schilder, 1932). The Recent Panamic *Z. (Z.) annettae* (Dall, 1909) ranges as far north as Laguna San Ignacio, Pacific coast of Baja California Sur, Mexico (ca. 26°44'N) and as far north as the head of the Gulf of California (ca. 31°37'N) (Burgess, 1985). *Zonaria (Z.) aequinoctialis* Schilder, 1933, the only other Panamic species of *Zonaria* s.s., ranges from Nicaragua to Peru (Burgess, 1985). The Recent *Z. (Z.) pyrum* (Gmelin, 1791) ranges as far north as the Mediterranean Sea in Europe (ca. 43°N) (Burgess, 1985) and is the only species of *Zonaria* from this region.

*Zonaria* s.s. disappeared from the Caribbean region in the late Miocene. The above mentioned Miocene northern ranges are similar to the Recent northern ranges of *Zonaria* s.s., and indicate similar climatic conditions for the Panamic and Mediterranean regions during the late early to middle Miocene. The presence of *Z. (Z.) emmakingae* and the associated warm-water gastropod genera *Nerita*, *Tonna*, and *Ficus* from the Topanga Canyon Formation indicate subtropical to tropical climatic conditions existed in what is now southern California (Susuki, 1951).



Explanation of Figures 2 to 5

Fossil and Recent species of *Zonaria* (*Zonaria*). Figures 2, 3. *Z. (Z.) emmakingae* Groves, sp. nov., holotype LACMIP 12277, from LACMIP loc. 5136,  $\times 1.5$ . Figures 4, 5. *Z. (Z.) annettae* (Dall, 1909), hypotype LACM 73-6.1, from LACM 73-6,  $\times 0.9$ .

*Zonaria* (*Zonaria*) *emmakingae* Groves, sp. nov.

(Figures 2, 3)

**Diagnosis:** A *Zonaria* s.s. with lengthened anterior, straight aperture, weak teeth on posterior canal; and smooth narrow fossula.

**Description:** Shell oblong, of medium size; spire covered; dorsum moderately arched; maximum height posterior of midpoint; aperture straight curving anteriorly toward columella; denticulation fine with smooth interstices; labial lip with 23 teeth; fossula smooth and narrow; basal marginal callus slight to moderate; terminal canals deep.

**Type Materials:** Holotype LACMIP 12277. The holotype measures 36.2 mm in length, 18.9 mm in width, and 17.2 mm in height.

**Type Locality:** LACMIP loc. 5136, central Santa Monica Mountains, Los Angeles County, southern California. The holotype was collected at the type section of the lower to middle Miocene ("Temblor Stage" = uppermost Burdigalian/Langhian), Cold Creek Member of Topanga Canyon Formation.

Arnold (1907:525-526) described a "Topanga Canyon fauna" at the head of Topanga Canyon, south of Calabasas, Los Angeles County, California. These outcrops were included in the type section of the Topanga Formation by Kew (1923:416-417), which he defined as middle Miocene marine exposures containing a "*Turritella ocoyana* fauna" overlying the Vaqueros Formation (lower Miocene) and underlying the Modelo Formation (upper Miocene). The type section of the formation consists of more than 2400 m of conglomerates, sandstones, and mudstones with intercalated basalts (Susuki, 1952). Yerkes & Campbell (1979) modified the formation name of Kew (1923) to the Topanga Canyon Formation of the Topanga

Group and described the Encinal, Saddle Peak, Fernwood, and Cold Creek members in the central Santa Monica Mountains. Flack (1990) reported the age of the Topanga Canyon Formation to be late early Miocene through middle Miocene, based on mollusks and benthic foraminiferas.

**Comparison:** The new species is most similar to *Zonaria* (*Zonaria*) *annettae* (Dall, 1909:125) from the Pliocene through Recent of Baja California Sur and the Gulf of California. *Zonaria* (*Z.*) *emmakingae* differs from *Z. (Z.) annettae* by having a greater lateral extension of the labial lip, a greater number of labial teeth, and a basal marginal callus.

**Discussion:** Post-depositional lateral crushing has concealed the columellar lip dentition of the holotype, which is the only known specimen of the new species. Generic and subgeneric assignments, therefore, are based on the straight aperture, the smooth narrow fossula, and the pear shape. *Zonaria* (*Z.*) *emmakingae* is the earliest species of the genus and subgenus from the eastern Pacific.

**Etymology:** The new species is named after Mrs. Emma L. King, Manhattan Beach, California, active member of the Southern California Paleontological Society, who found the holotype in 1973 and graciously donated it to LACMIP.

*Zonaria* (*Zonaria*) *annettae* (Dall, 1909)

(Figures 4-5)

*Cypraea ferruginosa* Kiener, 1843-1845:37-38, pl. 56, fig. 3.  
Not *Cypraea ferruginosa* Gmelin, 1791.

*Cypraea sowerbyi* Kiener, 1843-1845:38-39, pl. 7, fig. 3 [as *C. zonata*]; Reeve, 1845: pl. 10, sp. 40. Not *Cypraea sowerbyi* Gray, 1832; not Anton, 1839.

*Cypraea annettae* Dall, 1909:125; Durham, 1950a:116, pl.



30, figs. 7–8; Ingram, 1951:142–143, pl. 23, figs. 9–10; Cate, 1961:112–114, pl. 94, figs. 1–2b; Burgess, 1970: 347, pl. 42, fig. A; Walls, 1979:246, 2 unnumbered figs.; Burgess, 1985:102, 3 unnumbered figs.

*Zonaria annettae* (Dall, 1909): Smith, 1944:21, fig. 249; Schilder, 1958:83–85, fig. 4b.

*Zonaria* (*Zonaria*) *annettae annettae* (Dall, 1909): Cate, 1969: 113, pl. 12, figs. 9–11.

*Zonaria annettae annettae* (Dall, 1909): Allan, 1956:66, pl. 8, figs. 31–32; Lorenz & Hubert, 1993:117, pl. 61, figs. 1–9.

*Cypraea* (*Zonaria*) *annettae* Dall, 1909: Keen, 1958:330, fig. 287; Abbott, 1974:150, fig. 1642; pl. 5, fig. 1642.

*Cypraea* (*Zonaria*) *annettae annettae* Dall, 1909: Emerson & Old, 1963:12–14, fig. 14; Keen, 1971:495, fig. 933.

**Type Material:** The primary type material of *Cypraea ferruginosa*, *C. sowerbyi*, and *C. annettae* was not located.

**Type locality:** Of *C. ferruginosa*, type locality unknown. Kiener (1845:38) listed the type locality of *C. sowerbyi* as “l’Océan Pacifique, les côtes de la Californie.” Allan (1956: 66) cited California as the type locality of *C. annettae*.

**Geologic range:** Late Pliocene (“San Joaquin Stage” of Weaver et al. (1944) [= Piacenzian]) to Recent.

**Stratigraphic distribution:** PLIOCENE: Bahía Merquer, Isla del Carmen (Durham, 1950a; Emerson & Hertlein, 1964); Puerto Ballandra, Isla del Carmen (Emerson & Hertlein, 1964). PLEISTOCENE: Pacific Coast of Baja California Sur: Bahía Tortugas (Chace, 1956; Emerson & Old, 1963; Emerson, 1980; Emerson et al., 1981); Bahía Magdalena (Dall, 1918; Grant & Gale, 1931; Jordan, 1936). Gulf Coast of Baja California Sur: Bahía San Carlos (Emerson, 1959; Emerson & Old, 1963); Santa Rosalia (Grant & Gale, 1931); Punta Chivato (Durham, 1950a; Emerson & Old, 1963; SDSU loc. 2555); Mulegé (herein); Isla Coronado (Durham, 1950a; Emerson & Old, 1963; Emerson & Hertlein, 1964); Isla del Carmen (Durham, 1950a; Ingram, 1951; Hertlein, 1957; Emerson & Old, 1963); Loreto and Punta Escondido (Ingram, 1951); Isla Monserrate and Isla San Diego (Emerson & Hertlein, 1964); Punta Coyote (CAS loc. 48867); Isla Cerralvo (Emerson, 1960a; Emerson & Old, 1963); Los Frailes (CAS loc. 60496). Sonora: Punta Peñasco (Emerson & Old, 1963); Isla Tiburón (CAS loc. 55064); Bahía Bacohibampo (Ingram, 1951). HOLOCENE: Isla San Jose [shell midden] (Emerson, 1960b).

**Recent distribution:** Found throughout the Gulf of California and to Laguna San Ignacio, Pacific coast of Baja California Sur, Mexico (Burgess, 1985) and to Rocas Alijos (LACM 90–119.4).

**Remarks:** The figured specimen (LACM 73-6.1) measures 42.8 mm in length, 22.9 mm in width, and 19.0 mm in height, and is from Punta San Antonio, northwest of Bahía San Carlos, Guaymas, Sonora, Mexico. *Zonaria* (*Z.*) *annettae* represents a modern descendant of *Z.* (*Z.*) *em-makingae*.

## Subfamily EROSARIINAE Schilder, 1941

### Tribe Erosariini Schilder, 1924

#### Genus *Nucleolaria* Oyama, 1959

**Type Species:** *Cypraea nucleus* Linnaeus, 1758, by original designation. Middle Miocene through Recent, Indo-Pacific.

**Diagnosis:** Shell small to medium in size; coarse to fine dorsal nodules with fine inter-nodular threads; prominent dorsal sulcus; coarse ventral ribs; fossula smooth and deep.

**Remarks:** Linnaeus (1758) described *Cypraea nucleus*, the first species of “rough cowry” from the Indo-Pacific. An endemic Hawaiian species, *Cypraea granulata*, was described by Pease (1862) as distinct from *C. nucleus*. Schilder (1937) described *Staphylaea* (?) *soloensis* from the Pliocene of Java and later reassigned it to the genus *Nucleolaria* (Schilder & Schilder, 1971). Burgess (1965) described *Cypraea cassiui* from the Marquesas Islands, French Polynesia, and Flint and Starbuck Islands of the Line Islands, Kiribati. Schilder & Schilder (1971) assigned these related cypraeids to the genus *Nucleolaria* of Oyama (1959).

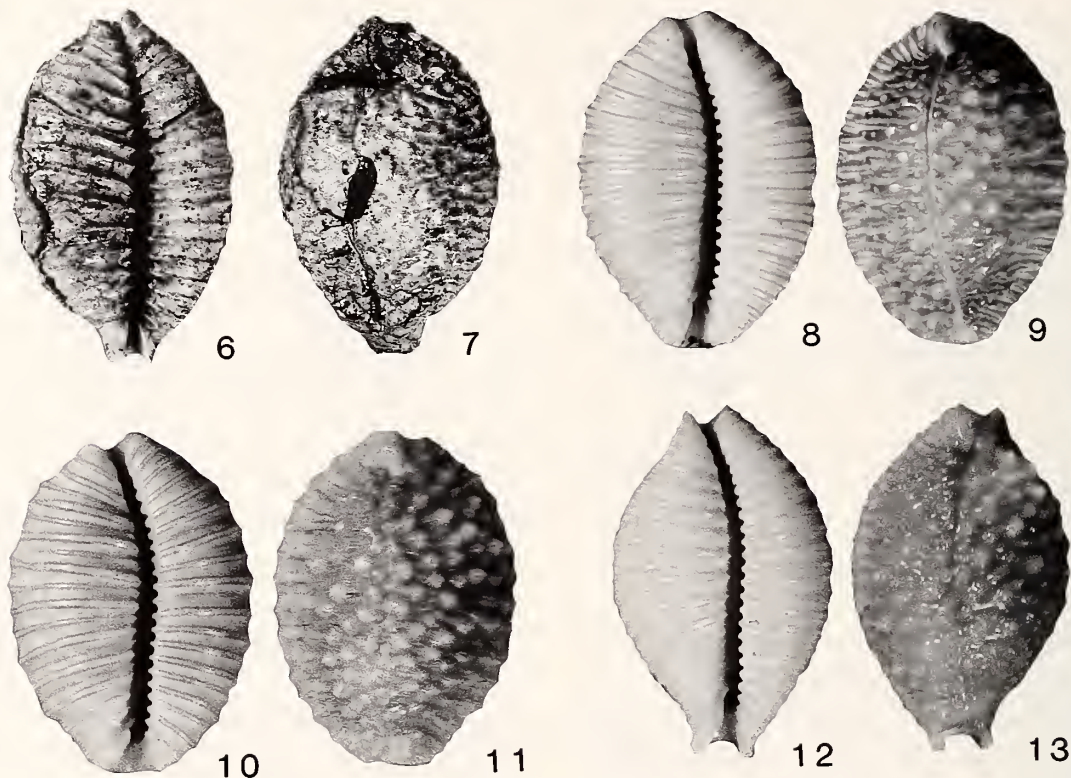
*Nucleolaria* is a tropical Indo-Pacific genus. The three living species *N. cassiui* (Burgess, 1965) [Recent only], *N. granulata* (Pease, 1862) [Pleistocene to Recent], and *N. nucleus* (Linnaeus, 1758) [Miocene to Recent] and the Pliocene *N. soloensis* (Schilder, 1937) are known only from localities within the Indo-Pacific region. The new species of *Nucleolaria* described herein from the middle to late Eocene of southwestern Washington provides additional evidence that tropical conditions existed in this region. Durham (1950b) reported that the tropics extended northward of 49°N along the Pacific coast of North America during most of the Eocene. Squires & Groves (1993) also documented a middle Eocene tropical climate in King County, Washington by the presence of the ovulid species *Sulcoocypraea matthewsonii* (Gabb, 1869) from the Tukwila Formation.

#### *Nucleolaria cowlitziana* Groves, sp. nov.

(Figures 6, 7)

**Diagnosis:** A *Nucleolaria* with prominent dorsal nodules connected by fine threads, a dorsal sulcus, and a deep fossula.

**Description:** Shell shape ovoid, medium in size; spire covered; maximum height slightly posterior of midpoint; dorsal groove faint; dorsal nodules smooth, circular, connected by fine threads that extend onto ventral surfaces and form prominent denticulation; slight marginal callus; aperture slightly curved posteriorly toward columella; denticulation prominent with smooth interstices, labial lip with 19 teeth, columellar lip with 18 teeth; fossula with strong denticulation; anterior and posterior canals prominently lengthened by terminal teeth.



Explanation of Figures 6 to 13

Fossil and Recent species of *Nucleolaria*. Figures 6, 7. *N. cowlitziana* Groves, sp. nov., holotype UCMP 39837, from UCMP loc. D-8040,  $\times 1.6$ . Figures 8, 9. *N. cassiaui* (Burgess, 1965), holotype BPBM 8910, from the Marquesas Islands, French Polynesia,  $\times 1.5$ . Figures 10, 11. *N. granulata* (Pease, 1862), hypotype LACM 149832, from Pokai Bay, Waianae District, Oahu, Hawaii,  $\times 1.8$ . Figures 12, 13. *N. nucleus* (Linnaeus, 1758), hypotype LACM 149833, from north of Auki, Malaita Island, Solomon Islands,  $\times 2.1$ .

**Type Material:** Holotype UCMP 39837. Represented only by the well-preserved holotype that displays original shell material and measures 27.2 mm in length, 17.3 mm in width, and 11.3 mm in height.

**Type Locality:** UCMP loc. D-8040, south-central Lewis County, Washington. The holotype was collected from type section of the middle to upper Eocene ("Tejon Stage" = uppermost Bartonian/lowermost Priabonian) Cowlitz Formation.

The Cowlitz Formation of Weaver (1912:11-14) was named for strata exposed 2.4 km (1.2 mi.) east of Vader, Lewis County, Washington, along the west bank of the Cowlitz River. Lithologies at the type section consist of thick-bedded, medium- to coarse-grained, brownish gray nearshore marine sandstone, as well as silty sandstone, sandy mudstone, estuarine and freshwater siltstones near the middle and intercalated basaltic flows near the base of the formation (Weaver, 1937). Nesbitt (1982) recognized three distinct faunal communities at the type locality: a *Turritella-Tivellina* community; a *Pitar* community; and a *Nuculana* community, which includes the new species of *Nucleolaria*.

**Comparison:** The new species is similar to the Recent *N. cassiaui* (Burgess, 1965:37-40, pl. 4, figs. E-H), *N. granulata* (Pease, 1862:278-279), and *N. nucleus* (Linnaeus, 1758:724). *Nucleolaria cowlitziana* differs from all three species by having a less prominent dorsal sulcus, finer dorsal nodules, a lower lateral profile, and stronger ventral ribbing. The ovulid species *Cypropterina (Jenneria) pustulata* (Lightfoot, 1786, ex Solander MS) lacks denticulation on the fossula.

**Discussion:** The excellent preservation allows for unequivocal generic assignment. *Nucleolaria cowlitziana* is significantly different from all other eastern Pacific cypraeids and is the earliest member of this genus worldwide, as well as the only representative of the genus in the eastern Pacific region.

**Etymology:** The name refers to the Cowlitz Formation.

*Nucleolaria cassiaui* (Burgess, 1965)

(Figures 8, 9)

*Cypraea cassiaui* Burgess, 1965:38-40, pl. 40, figs. E-H; Burgess, 1970:37-38, pl. 1, fig. C; Burgess, 1985:234, 3



unnumbered figs.; Cook & Cook, 1992:5, 3 unnumbered figs.

*Nucleolaria nucleus cassiaui* (Burgess, 1965); Schilder & Schilder, 1971:66, 103.

*Naria* (*Nuclearia*) *granulata cassiaui* (Burgess, 1965): Cossignani & Passamonti, 1991:21, 41.

*Staphylaea granulata cassiaui* (Burgess, 1985): Lorenz & Hubert, 1993:216, pl. 101, figs. 30–31, 33–34.

**Type Material:** Holotype BPBM 8910; paratypes, ANSP 80860 and 80063. The holotype measures 29.4 mm in length, 17.5 mm in width, and 13.7 mm in height.

**Type Locality:** Marquesas Islands, French Polynesia (Burgess, 1965).

**Geologic Range:** Recent only.

**Remarks:** *Nucleolaria cassiaui* differs from other “rough cowries” by having a unique dorsal groove that is a trench-like slit, which is not encroached upon by the adjacent tubercles and threads.

**Recent Distribution:** This species is only known from the Marquesas Islands, French Polynesia, and Starbuck and Flint Islands in the Line Islands, Kiribati (Burgess, 1985).

*Nucleolaria granulata* (Pease, 1862)

(Figures 10, 11)

*Cypraea granulata* Pease, 1862:278–279; Kay, 1965:79–80, pl. 14, figs. 17–18; Kosuge, 1969:785, 789, pl. 4, fig. 60; Burgess, 1970:263–264, pl. 29, figs. I–J; Kay, 1979:193, frontis., third row; Walls, 1979:140, 2 unnumbered figs.; Burgess, 1985:236, 3 unnumbered figs.

*Cypraea madagascarensis* Gmelin, 1791: Kiener, 1843–1845: 126–127, pl. 3, fig. 4; Reeve, 1845: pl. 15, sp. 75; Sowerby, 1870:41, pl. 33, figs. 406–408. Not *Cypraea madagascarensis* Gmelin, 1791.

*Cypraea honoluluensis* Mevill, 1888:245.

*Staphylaea* (*Nuclearia*) *granulata* (Pease, 1862): Cate, 1965: 51–52, pl. 5, figs. 7a–b.

*Staphylaea granulata* (Pease, 1862): Morris, 1966:233, pl. 68, fig. 7.

*Nucleolaria nucleus granulata* (Pease, 1862): Schilder & Schilder, 1971:66, 119.

*Naria* (*Nuclearia*) *granulata* (Pease, 1862): Cossignani & Passamonti, 1991:21, 64.

*Staphylaea granulata granulata* (Pease, 1862): Lorenz & Hubert, 1993:215, pl. 101, figs. 19–29, 32.

**Type Material:** Kay (1965:80) selected a lectotype BMNH 1964306 and three paralectotypes BMNH 1964307. The lectotype was selected because it best represented the details of the description given by Pease.

**Type Locality:** “Sandwich Islands” (= Hawaiian Islands) (Sowerby, 1870).

**Geologic Range:** Pleistocene to Recent.

**Stratigraphic Distribution:** PLEISTOCENE: Oahu, Hawaii (Kosuge, 1969).

**Recent Distribution:** Limited to the Hawaiian Archi-

pelago from Kure Atoll to the Island of Hawaii and collected from Holocene deposits on Johnston Island in January, 1964 (Burgess, 1985).

**Remarks:** The figured specimen (LACM 149832, *ex* L. T. Groves coll.) measures 23.6 mm in length, 17.3 mm in width, and 10.9 mm in height and is from Pokai Bay, Waianae District, Oahu, Hawaii. *Nucleolaria granulata* is most similar to *N. cassiaui*, but the dorsal groove is less prominent in *N. granulata*.

*Nucleolaria nucleus* (Linnaeus, 1758)

(Figures 12, 13)

*Cypraea nucleus* Linnaeus, 1758:724; Kiener, 1843–1845:127, pl. 3, fig. 2; Reeve, 1845: pl. 15, sp. 70; Sowerby, 1870: 40, pl. 33, figs. 399–400; Woodward, 1879:497–498, pl. 13, figs. 7a–b; Vlerk, 1931:244; Kosuge, 1969:785, 793; Burgess, 1970:261, pl. 29, fig. H; Kay, 1979:197, figs. 68.C–D; Walls, 1979:205, 2 unnumbered figs.; Burgess, 1985:235, 3 unnumbered figs.

*Cypraea madagascarensis* Gmelin, 1791:3419; Ostergaard, 1928:6; Ostergaard, 1939:70, 72–73, 76.

*Cypraea* (*Pustularia*) *nucleus* Linnaeus, 1758: Ladd, 1945: 366, pl. 52, figs. Q–S.

*Staphylaea* (*Nuclearia*) *nucleus* (Linnaeus, 1758): MacNeil, 1960:51–52, pl. 19, figs. 5–6.

*Staphylaea nucleus* (Linnaeus, 1758): Cernohorsky, 1967:84, pl. 13, fig. 70.

*Nucleolaria nucleus nucleus* (Linnaeus, 1758): Schilder & Schilder, 1971:66, 138.

*Cypraea* (*Staphylaea*) *nucleus* Linnaeus, 1758: Ladd, 1977: 24, pl. 5, figs. 4–6.

*Naria* (*Nuclearia*) *nucleus* (Linnaeus, 1758): Cossignani & Passamonti, 1991:21, 90.

*Nucleolaria nucleus* (Linnaeus, 1758): Lorenz, 1992:28, pl. 10, figs. 104–105.

*Staphylaea nucleus nucleus* (Linnaeus, 1758): Lorenz & Hubert, 1993:214, pl. 101, figs. 1–3, 7–19, 13–15.

*Staphylaea nucleus madagascarensis* (Gmelin, 1791): Lorenz & Hubert, 1993:215, pl. 101, figs. 4–6, 10–12, 16–18.

**Type Material:** Type material not located.

**Type Locality:** Of *C. nucleus*, “l’océan des grandes Indes et la mer Pacifique” (Kiener, 1844:127); Ambon (= Amboina), Pulau Ambon, Indonesia (Allan, 1956). Of *C. madagascarensis*, “Madagascar et l’océan Pacifique” (Kiener, 1844:126).

**Geologic Range:** Middle Miocene to Recent.

**Stratigraphic Distribution:** MIOCENE: Nias Island, Indonesia (Woodward, 1879; Vlerk, 1931). PLEISTOCENE: Ndalithoni Formation, Vanua Mblavu Island, Fiji (Ladd, 1945; 1977). PLEISTOCENE: Yontan Limestone, Okinawa (MacNeil, 1960); Oahu, Hawaii (Ostergaard, 1928 [as *Cypraea madagascarensis*]; Kay, 1961; Kosuge, 1969); Molokai, Hawaii (Ostergaard, 1939 [as *Cypraea madagascarensis*]; Hurghada, Egypt (Lorenz, 1992).

**Recent Distribution:** Found throughout the Indo-Pacific (Burgess, 1985).

**Remarks:** The figured specimen (LACM 149833, *ex L.* T. Groves coll.) measures 22.2 mm in length, 19.0 mm in width, and 11.2 mm in height and is from Malaita Island, Solomon Islands. *Nucleolaria nucleus* is less ovate than the other "rough cowries" and has more prominent terminal extremities.

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#### LOCALITIES CITED

- CAS loc. 48867. Raised beach at Punta Coyote, ca. 22 km northeast of La Paz, Baja California Sur, Mexico. Collector: A. G. Smith, 3 November 1954. Pleistocene.
- CAS loc. 55064. Lowest terrace ca. 30 m (100 ft.) from shore in a prominent bay directly north of Isla Turner, southeastern part of Isla Tiburón, Gulf of California, Mexico. Collector: T. Stump, 1974. Pleistocene.
- CAS loc. 60496. Sea-facing sandstone outcrop 3.2 km (2 mi.) southwest of Morro los Frailes and 49.8 km (31 mi.) northeast of San Jose del Cabo, Baja California Sur, Mexico, 23°22'N, 109°25'W. Collector: C. Baumbach, 8–9 July 1979. Pleistocene.
- LACM 73–6. Intertidal, rocky bar leading to Isla Venado, Punta San Antonio, northwest of Bahía San Carlos, Guaymas, Sonora, Mexico, 27°58'N, 111°07'W. Collectors: J. H. McLean & J. Margetts, 30–31 January 1973. Recent.
- LACM 90–119. 20–50 m depth (65–164 ft.), rocks and pinnacles of Rocas Alijos, Pacific Coast Baja California Sur, Mexico, 24°57.59'N, 114°44.92'W. Collectors: R. Schmieder, M. K. Wicksten, and R. Van Syoc, R/V *Qualifier*, 31 October–7 November 1990. Recent.
- LACMIP loc. 5136. Exposures in prominent roadcut ca. 5.3 km (3.3 mi.) south of U.S. Highway 101 on south side of Old Topanga Road ca. 30 m (100 ft.) upslope from a conspicuous bed of turritellas in roadcut, NW¼ SW¼ sec. 35, T1N, R17W, SBBM, Malibu Quadrangle, Los Angeles County, California. Collector: E. L. King, 10 August 1974. Lower to middle Miocene ("Temblor Stage" = uppermost Burdigalian/Langhian), Topanga Canyon Formation.
- SDSU loc. 2555. Second and largest arroyo west of 1224 m (4000 ft.) runway, Punta Chivato, ca. 22.4 km north-east of Mulegé, Gulf of California, Baja California Sur, Mexico. Collector: J. L. Egan, April 1972. Pleistocene.
- UCMP loc. D-8040. Northwest bank of the Cowlitz River bend, down dirt road to city water pump facility, 2.4 km (1.5 mi.) east of Vader, SW¼ sec. 27, T11N, R2W, and center of NW¼ sec. 33, T11N, R2W, WBM, Castle Rock Quadrangle, Lewis County, Washington. Middle to upper Eocene ("Tejon Stage" = uppermost Bartonian/lowermost Priabonian), Cowlitz Formation.

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